Atmospheric Radiation Measurement Program
www.arm.gov
ARM

August 2003

ARM Facilities Newsletter

ANL/ER/NL-03-08

New Atmospheric Profiling Instrument Added to SGP CART Suite

A new atmospheric profiling instrument at the SGP CART site is giving researchers an additional useful data stream. The new instrument is a microwave radiometer profiler (MWRP) developed by Radiometrics Corporation.

One ARM Program focus is improving the quality of simulations by global climate models, particularly models that deal with interactions between sunlight (solar radiation) and clouds. To support this improvement, ARM needs measured vertical profiles of atmospheric variables such as temperature and water vapor.

To obtain the needed measurements, the SGP facility launched approximately 2,200 weather balloons (radiosondes) in the past year, at a cost for supplies and labor in excess of $450,000. Radiosondes collect temperature and water vapor measurements as they ascend skyward, taking almost two hours to rise to their maximum height. The ascent time limits the frequency at which radiosondes can be released. During an intensive operation period at the SGP, balloon launches occur every three hours, but the normal interval is about six hours.

The slowly rising radiosonde produces temperature and water vapor measurements that are close together in terms of altitude, but a particular height is sampled only once for each launch. Consequently, radiosonde measurements are made at smaller altitude intervals than a climate model typically needs, but at longer-than-optimal time intervals. In contrast, solar radiation measurements made by instruments on the ground are at intervals of just minutes. Thus, the two sets of data do not match.

ARM Facilities Newsletter is published by Argonne National Laboratory, a multiprogram laboratory operated by The University of Chicago under contract W-31-109-Eng-38 with the U.S. Department of Energy.

Technical Contact: James C. Liljegren
Phone: 630-252-9540
Email: jcliljegren@anl.gov
Editor: Donna J. Holdridge

To achieve measurements at time and space intervals equivalent to those required by computer models, over the years ARM has deployed several additional ground-based remote-sensing instruments to collect temperature and water vapor data. Although this helped, the ground-based instruments could not measure to the desired altitudes consistently and under all weather conditions (e.g. clear and cloudy, day and night).

Figure 1. The microwave radiometer profiler (MWRP), deployed at the ARM North Slope of Alaska central facility in Barrow, Alaska (ARM photo).

To address the issues about time and space resolution, Radiometrics Corporation developed the new MWRP for ARM through a Department of Energy Small Business Innovative Research grant. The MWRP can collect continuous, real-time vertical profiles of atmospheric temperature, water vapor, and cloud liquid water from the surface to 6.2 miles into the atmosphere, in nearly all weather conditions.

Earth's atmosphere is continually radiating microwave energy. The MWRP measures this microwave energy in 12 distinct frequency bands and determines the equivalent atmospheric temperature and water vapor values at 47 different levels above the surface by using a neural network system. The MWRP, unattended, operates continuously for long periods of time. The instrument collects profile data every five minutes, providing finer time resolution than the radiosonde and data that are more suitable for use in climate models and weather prediction models.

The MWRP has been thoroughly tested at the ARM SGP and North Slope of Alaska CART sites. It was deployed at the SGP site from February 2000 until September 2000, when it was moved to Alaska to work through the arctic winter until April 2001. After a brief repair, the instrument was shipped back to Oklahoma, where it collected data from June 2001 until October 2002. The MWRP demonstrated its robustness by working almost flawlessly during hot SGP summers and a cold arctic winter.

After a three-year intensive evaluation by instrument mentor and SGP program manager Dr. James Liljegren, the MWRP has proven to be a reliable, accurate instrument for measuring vertical profiles of temperature and water vapor. The MWRP is currently being installed as a permanent ARM instrument, and its data stream is being added to the ARM data archive.

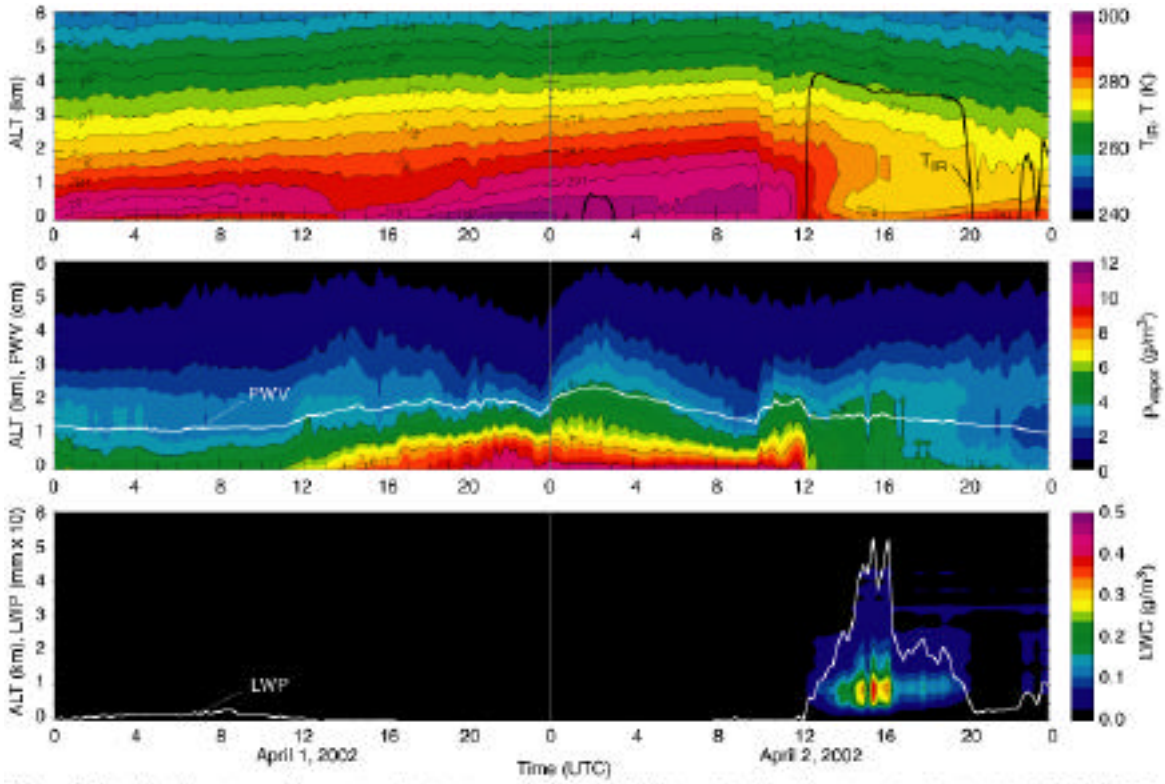

Figure 2. Time-height contours of temperature (top), water vapor density (middle), and cloud liquid water (bottom) for 1-2 April 2002 at the ARM SGP site near Lamont, Oklahoma. The heavy black line in the top panel indicates the sky temperature reported by the infrared thermometer. The heavy white lines in the middle and bottom panel indicate the precipitable water vapor and liquid water path, respectively.